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September 2009

Online at <http://mpra.ub.uni-muenchen.de/27763/>  
MPRA Paper No. 27763, posted 30. December 2010 / 04:11

## **Inflation Expectations Formation and Financial Stability in Indonesia**

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**Abstract:** This paper examines the role of expectations in explaining the dynamics of inflation, interest rates and other key financial variables in Indonesia using VAR and error correction analyses. It is found that deposit interest rates, exchange rates and oil prices have significant impact on the expectations formation. We also found that administered prices are important, but their role decreases with time, while exogenous shocks remain a major source of movements in the expectations. The latter has long lasting effects and still accounts for more than 10 per cent of the variability of inflation expectations after the period of one year. This evidence shows the importance of inflation expectations formation, particularly on domestic financial stability.

**Keywords:** Inflation Expectations, Formation, Financial Stability, Indonesia

**JEL Classification Number:** E31, E42, E58, E61, G28

### **1. Introduction**

Understanding the formation of survey-based public expectations has long been an important subject in macroeconomic research. The issue is particularly appealing, because of the different characteristics of variables that form the expectations from one economy to another, depending on domestic and global circumstances (Dahl and Hansen, 2001). Until recently, there has been no standard criterion in the literature that specifies what variables to include in the models of inflation expectations formation.

De Carvalho and Bugarin (2006) identified that expectation formations could be influenced by output, exchange rates, interest rates, past supply and demand and inertia conditions. Mehra and Herrington (2008) elaborate that the inflation expectations in the United States moved in response to several macroeconomic shocks, namely actual inflation, commodity prices, particularly the oil prices, and unemployment. It is observed that the shock of expected inflation itself had been one of the major sources of movement in the U.S. expectations.

In the meantime, although the inertia has been influential in determining the wages and prices at production levels in Indonesia (Bank Indonesia 2003; Majardi 2004), the case has

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not been investigated from the customers' survey data of inflation expectations. This study aims to analyse the inflation expectations formation while utilizing the customers' survey data conducted by Bank Indonesia.

There are three objectives outlined in this paper: (i) to understand the variables that influence the formation of inflation expectations; (ii) to analyse the changes in the movements of inflation expectations as a result of economic shocks; and (iii) to measure how Bank Indonesia can better utilize public expectations. The paper is presented as follows. Section 2 provides information about data and methodology. Section 3 provides empirical results and findings. Section 4 discusses the economic shocks and changes of the expectations and Section 5 concludes the paper.

## **2. Data and Methodology**

The data used in this study covers a range of macroeconomic variables aimed at providing possibilities of every variable to influence the relationship of public expectations and the outcomes of actual inflation. There is a lack of commitment among authors on what specific variables to include in the estimations of the public expectations of inflation. The potential variables that are considered here include: administered prices (ADMPR), Jakarta composite stock index (JCSX), money supply (LM1), deposit interest rates (LPSR), rupiah exchange rates against US dollar (LUSXR), consumption credit interest rates (CONSR), investment credit interest rates (INVR), working capital credit interest rates (WKCPR), Bank Indonesia's policy interest rates (BIPR) and inflation expectations (EXPM). The latter is derived from the monthly survey data conducted by Bank Indonesia

### **2.1. Principal Components Analysis**

In order to select only the most fitting variables that explain the movements of the inflation expectations, this study utilizes the principal components analysis method (PCA). The use of PCA allows the number of variables in a multivariate data set to be reduced, while retaining as much as possible the variation present in the data set (Smith, 2002).

When using PCA, it is hoped that the eigenvalues of most of the non-dominant principal components (PCs) will be so low as to be virtually negligible. The analysis is performed on a dataset of  $n$  variables for  $m$  individuals. Then, a corresponding squared covariance or correlation matrix can be calculated. For the covariance matrix the following equation can be used:

$$Cov(X_j, X_k) = \frac{\sum_{i=1}^m (X_{ij} - \bar{X}_j)(X_{ik} - \bar{X}_k)}{(m-1)} \quad (1)$$

where  $\bar{X}_j = \frac{\sum_{i=1}^m X_{ij}}{m}$  and  $j, k = 1, 2, 3, \dots, n$ .

It also could be expressed in the form: 
$$S = \begin{bmatrix} S_{11} & S_{12} & S_{13} & S_{1n} \\ S_{21} & S_{22} & S_{23} & S_{2n} \\ \cdot & \cdot & \cdot & \cdot \\ \cdot & \cdot & \cdot & \cdot \\ S_{n1} & S_{n2} & S_{n3} & S_{nn} \end{bmatrix} \quad (2)$$

where  $S$  is the covariance matrix,  $S_{jk}$  is the covariance of variables  $X_j$  and  $X_k$  when  $j \neq k$  and the diagonal element  $S_{jj}$  is the variance of  $X_j$  when  $j = k$ .

When variables have different units or widely different scales, a correlation matrix where variables are standardized should be used (Smith, 2002). Eigenvectors (PCs) and their associated eigenvalues can be calculated from the correlation matrix by an iterative process. The first principal component ( $PC_1$ ) is a linear combination of the original variables  $X_1, X_2, X_3, \dots, X_n$  such that:

$$PC_1 = a_{11}X_1 + a_{12}X_2 + a_{13}X_3 + \dots + a_{1n}X_n = \sum_{j=1}^n a_{1j}X_j \quad (3)$$

$$PC_1 = \sum_{j=1}^n a_{1j}X_j \quad (4)$$

and it is subject to the condition that  $a_{11}^2 + a_{12}^2 + a_{13}^2 + \dots + a_{1n}^2 = 1$  where  $a_{11}, a_{12}, \dots, a_{1n}$  are coefficients assigned to the original  $n$  variables for  $PC_1$ . In the same way, we could derive  $PC_n$  and write  $n$  principal component as:

$$PC_n = \sum_{j=1}^n a_{nj}X_j \quad (5)$$

where the eigenvalue of  $PC_n$  is as large as possible subject to the constraint that  $a_{n1}^2 + a_{n2}^2 + a_{n3}^2 + \dots + a_{nn}^2 = 1$  and subject to the condition that all individual principal components are uncorrelated.

## 2.2. Unit root and Cointegration Tests

We employed the augmented Dicky-Fuller (ADF) unit root procedure to test the order of integration for each of our series. The unit root tests were conducted without constant and trends to capture the characteristics of the tested variables. Furthermore, since the cointegration tests of the variables in this study involved more than two variables, the Johansen cointegration test was performed (Johansen, 1991), producing two statistics (the trace and maximum eigenvalue tests) expressed as:

$$J_{trace} = -T \sum_{i=r+1}^n \ln(1 - \hat{\lambda}_i) \quad (6)$$

$$J_{max} = -T \ln(1 - \hat{\lambda}_{r+1}) \quad (7)$$

## 2.3. VAR Model Representations

Here we use a vector autoregression (VAR) model that allows for the potential presence of contemporaneous feedbacks among all the influencing variables contained in the system. The procedure presented in this section followed Hamilton (1994) and can be represented as:

$$\vec{\pi}_t = \alpha + \Phi_1 \vec{\pi}_{t-1} + \dots + \Phi_n \vec{\pi}_{t-n} + \varepsilon_t \quad (8)$$

where  $\vec{\pi}_t$  is a vector of variables;  $\Phi$  is a matrix of structural coefficients, and  $\varepsilon_t$  is a vector of structural shocks. To identify the impulse response functions, we could derive the model from equation (8) and since any covariance stationary has a *Wold representation* in the form of:

$$\vec{\pi}_t = \alpha + \varepsilon_t + \Psi_1 \varepsilon_{t-1} + \Psi_2 \varepsilon_{t-2} + \Psi_3 \varepsilon_{t-3} + \dots \quad (9)$$

then, the matrix  $\Psi_s$  has the interpretation:

$$\frac{\partial \vec{\pi}_{i,t+s}}{\partial \varepsilon_{j,t}} = \psi_{js} \quad (10)$$

that is the row  $i$ , column  $j$  element of  $\Psi_s$  identifies the consequences of a one-unit increase in the  $j$ -th variable's innovation at time  $t$  ( $\varepsilon_{j,t}$ ) for the value of the  $i$ -th variable at time  $t+s$  ( $\vec{\pi}_{i,t+s}$ ), holding all other innovations at all times constant.

### 3. Empirical Results

#### 3.1. Principal Component Analysis

Table 1 below shows the eigenvalues of the correlation matrix. First, in order to decide how many PCs should be retained, we have to start from the first component, the one with the largest eigenvalue that describes a certain proportion of the total variance. As clearly shown, the first component accounts for 68.02% of the total information. However, the literature suggests that a sufficient percentage to represent the total variation is 70% to 90% (Jolliffe, 1986). Thus, the combination of the first and second components account for 85.72% of the total information, which is sufficient.

According to the Kaiser's rule (Lance et al., 2006), the principal components to be retained are those whose eigenvalue is  $\geq 1$  which are PC<sub>1</sub> and PC<sub>2</sub>. The decision for retaining those particular eigenvalues is due to the fact that the principal components analysis was conducted using a correlation matrix, where this calculation assumes standardised scores.<sup>3</sup> Based on the above criteria, we could only have two principal components for the analysis.

**Table 1: Principal Components Analysis (Reduced Using Correlation Matrix)**

Number	Eigenvalue	Difference	Proportion	Cumulative Eigenvalue	Cumulative Proportion
1	5.441250*	4.024814	0.6802	5.441250	0.6802*
2	1.416437*	0.617269	0.1771	6.857687	0.8572*
3	0.799168	0.542066	0.0999	7.656855	0.9571
4	0.257102	0.205760	0.0321	7.913957	0.9892
5	0.051342	0.026285	0.0064	7.965299	0.9957
6	0.025057	0.018122	0.0031	7.990356	0.9988
7	0.006935	0.004227	0.0009	7.997292	0.9997
8	0.002708	---	0.0003	8.000000	1.0000

Notes: Sum of the Eigenvalue = 8 and the average = 1. \* means the number of principal components retained.

From the results of obtained eigenvectors presented in Table 2, there are two different factors that might explain the movements of inflation expectations, and LPSR is found in both factors. Based on the above information and taking into consideration the correlation matrix presented in Table 3, we can determine the variables that influence the formation of inflation expectations are based on the highest positive variances (eigenvectors). Accordingly, we suspect that the inflation expectations in Indonesia are influenced by administered prices, exchange rates, deposit interest rates and consumption credits.

<sup>3</sup> In assessing the robustness of our results, we have also conducted a scree plot test which confirmed our previous preliminary findings. The result is available upon request.

**Table 2: Principal Components Analysis (Eigenvectors)**

Variable	PC 1*	PC 2*	PC 3	PC 4	PC 5	PC 6	PC 7	PC 8
LPSR	0.343363	0.391306^	0.35189	0.297885	-0.58504	-0.26488	-0.226450	0.229571
LUSXR	-0.196168	0.628927^	-0.43584	0.539296	0.248811	0.152070	0.008848	0.007941
CONSR	0.402260^	-0.206001	0.193175	0.229878	0.411601	0.456448	-0.535617	0.202347
INVR	0.424007^	-0.002699	0.094262	0.107465	0.369032	-0.21725	0.659168	0.426491
WKCPR	0.415125^	0.124603	0.204503	0.125749	0.118198	0.001479	0.164562	-0.84466
ADMPR	0.269426	0.570123^	-0.08175	-0.73213	0.105165	0.180730	-0.093887	0.084469
JSCX	-0.349595	0.168765	0.596241	0.03019	-0.10194	0.596154	0.351875	0.057267
LM1	-0.367274	0.199598	0.485805	-0.05740	0.504773	-0.51294	-0.259891	-0.02288

Notes: (\*) means the number of principal components retained. (^) denotes components association in each retained principal component.

**Table 3: Principal Components Analysis (Ordinary Correlation Matrix)**

Variable	LPSR	LUSXR	CONSR	INVR	WKCPR	ADMPR	JSCX	LM1
LPSR	1.000000							
LUSXR	-0.10767	1.000000						
CONSR	0.694877	-0.64133	1.000000					
INVR	0.815012	-0.46895	0.952855	1.000000				
WKCPR	0.907447	-0.38439	0.912709	0.978158	1.000000			
ADMPR	0.736151	0.149291	0.372157	0.593711	0.672515	1.000000		
JSCX	-0.39104	0.321001	-0.71721	-0.76496	-0.66178	-0.41893	1.000000	
LM1	-0.45470	0.397145	-0.78477	-0.80196	-0.71403	-0.39761	0.966449	1.000000

### 3.2. Stationarity and Equilibrium Relationships

As presented in Table 4, all variables are integrated of order I(1), except for CONSR. Stationarity is achieved after first-differencing of series except for CONSR variable.

Haris and Solis (2003) noted that seasonal unit roots are not encountered very often in several macroeconomic time series. Research findings by Osborn (1990) with the United Kingdom's consumption expenditures also support this argument. Therefore, we also argue here that the absence of additional roots will not invalidate the non-seasonal unit root tests.

**Table 4: Results of the Unit Root Tests**

Variables	ADF			
	Lags	Levels	D(x)*	Integration order
LPSR	1	-2.215	-3.212	I(1)
ADMPR	1	-1.551	-5.475	I(1)
CONSR	1	-1.232	-2.851	I(2)
LUSXR	1	-0.255	-7.571	I(1)

Note: The decision to reject null hypothesis is based on ADF 5% critical value as -2.902. D(x)\* denotes the first difference of the tested variables, except for CONSR which is integrated of order I(2).

Next, we applied the Johansen cointegrating test, and the results are presented in Table 5. It is observable that both the trace and the maximum eigenvalue tests indicate the existence of one cointegrating rank of their respective time series within the system.

**Table 5: Results of the Johansen Cointegration Test**

H <sub>0</sub>	H <sub>1</sub>	Trace Statistic	95% Critical value	Max-Eigen statistic	95% Critical value
-	$r \geq 0$	54.50333*(**)	47.85613	28.01159*(**)	27.58434
$r = 0$	$r \geq 1$	26.49175	29.79707	12.49802	21.13162
$r \leq 1$	$r \geq 2$	13.99373	15.49471	10.01142	14.26460
$r \leq 2$	$r \geq 3$	3.982308*(**)	3.841466	3.982308*(**)	3.841466

Note: \* and \*\* denotes statistical significance at the 5% and 10% levels respectively.

We argue that the presence of one cointegrating vector from the trace test and the maximum eigenvalue statistic confirm that there exists at least one long-run equilibrium relationship between EXPM and the tested variables (ADMPR, LPSR and LUSXR). Having done the above analysis, we can now run an error correction model (ECM) to see the relationship between EXPM and all influential variables, both in the short run and long run in order to understand how each variable makes adjustments towards the long-run equilibrium.

**Table 6: Basic Estimation Results of Error Correction Models**

$$\text{EXPM} = 428.27 + 0.25\text{LSPR} - 46.1\text{LUSXR} + 0.05\text{ADMPR}$$

(2.0)\*                      (-5.9)\*\*

Variable	Coefficient	t-statistics	Variable	Coefficient	t-statistics
ECM	-0.0334**	-2.032	$\Delta\text{LUSXR}(-1)$	2.4844**	4.717
$\Delta\text{EXPM}(-1)$	-0.0614	-0.452	$\Delta\text{ADMPR}(-1)$	-0.02279	-1.194
$\Delta\text{LPSR}(-1)$	0.0697	0.226			

Note: \* and \*\* denotes statistical significance at 10% and 5% levels respectively.



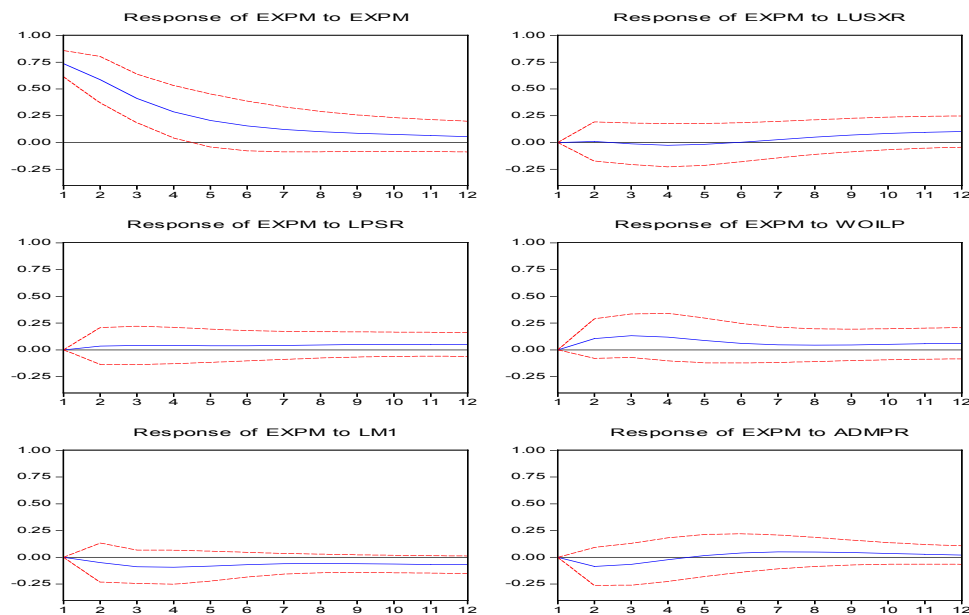
We observe that the movements of the deposit interest rates have significant impact on the expectations. Thus an increase in the long-run interest rates would result in the increase of the costs of investment, and eventually this affects the prices of goods produced in the market. A similar relationship is observed for the LUSXR where in the long run an appreciation of the rupiah will eventually increase the prices of goods, although the short-run dynamic adjustment results show a different sign. Interestingly, the impact of the administered prices is not significant in the long run, nor is it significant in the short run.

#### 4. Economic Shocks and Changes of Expectations

Figure 2 shows the effects of individual, one-time surprise increases in deposit interest rates, nominal exchange rates, administered prices, oil prices and money supply on survey-based expected inflation. From the figure, the solid line indicates the point estimate.

In response to the expectations shocks itself, the expected inflation became stable after a 12-month period. It tells us that the effect of the administered price policy imposed by the government decreased the inflation expectations in the first quarter, but then increased again in response to the changes of the regulated commodity prices before it became stable after a one-year period. In the case of the exchange rate, the immediate impact was really critical, but in the longer periods, the impact of the shocks are increasing with time.

**Figure 2: The responses of inflation expectations to different shocks.**



On the other hand, a sudden increase in LPSR means tight monetary policy, which affected investments and produced negative effects on market prices. As expected, people see that an increase in the interest rates will result in the prices permanently increasing over a longer term period. Furthermore, an increase in money supply is aimed at accommodating the pressures on interest rates and exchange rates rather than to achieve the target of money supply itself.

We also look at the response of public expectations to global oil price shocks (WOILP). As can be predicted, oil price hikes seem to have an immediate impact on expectations. People anticipated that the global oil price shocks would put the government under pressures. As the result, the effect became permanent and increased over longer periods as the oil prices affected other important commodities, such as electricity and transportation.

## **5. Conclusions**

Having examined the sources of movements of inflation expectations in Indonesia, our findings indicate that there are several monetary instruments that influence the inflation expectations which Bank Indonesia can use to anchor expectations. First, the Bank can utilize interest rates as the main variable to anchor public expectations as it has a significant influence on their formation. This could be conducted through strengthening its policy on interest rates much further. The effect of deposit interest rates on future inflation expectations provides evidence that the Bank has taken the appropriate step to conduct its monetary policy through managing market interest rates, as it is more responsive to the changes in policy rates.

Also important is the policy on exchange rates. The movement of rupiah exchange rates, particularly against the US dollar, has been significant in influencing the movement of public expectations. This, in turn, could be utilised by the Bank to persuade the public to follow the Bank's objectives. While the exchange rate regime in Indonesia is a managed floating one, the Bank can still continue playing a significant role in the exchange rate market in order to reduce volatility of the rupiah in the short term. The best way to conduct this market intervention is by allowing the rupiah to float within the target band set up by the Bank. This policy will provide a signal to the domestic market that the Bank is adopting a free floating exchange rate regime, but is ready to protect the interest of the public should the exchange rates fluctuate widely.

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